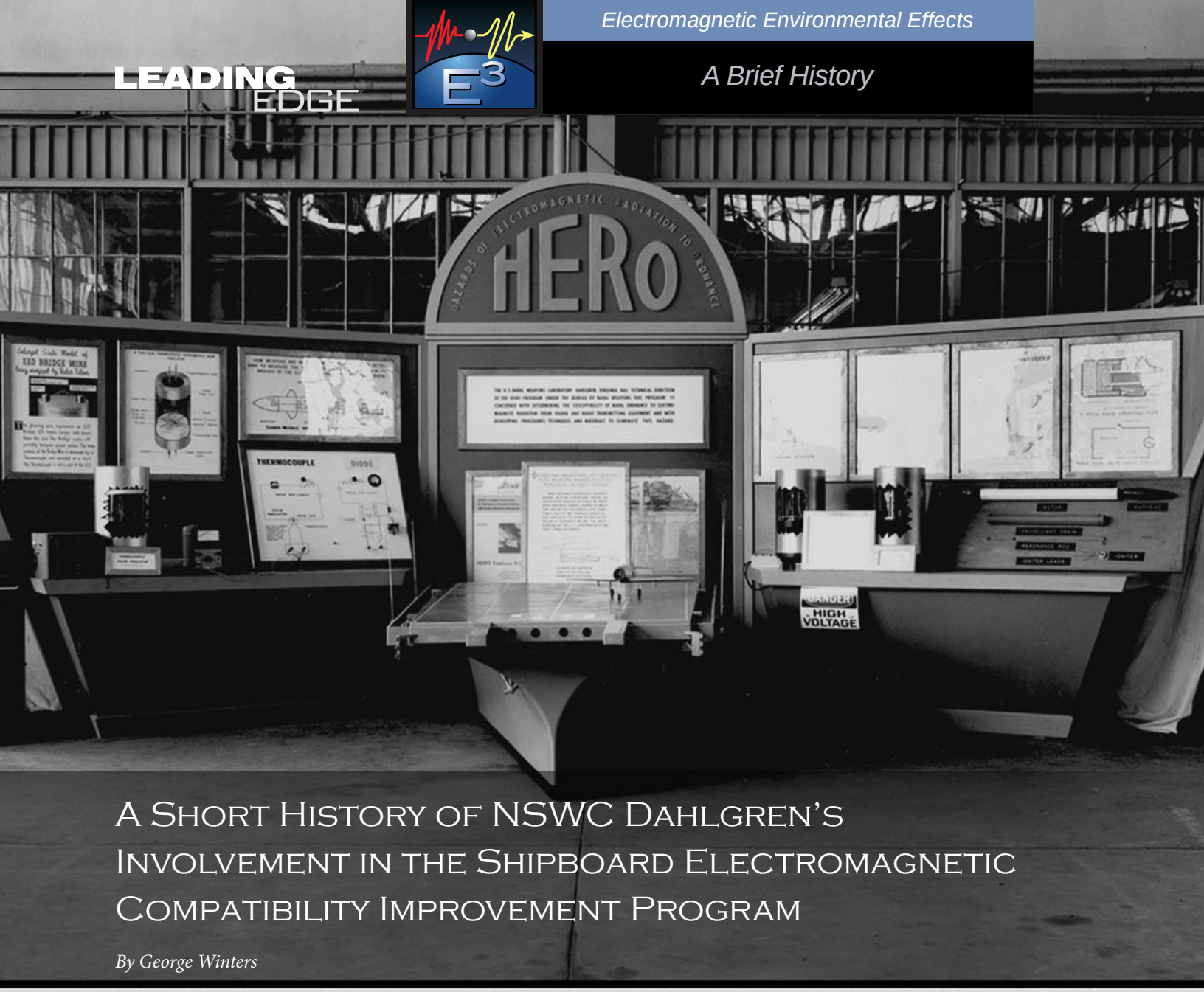


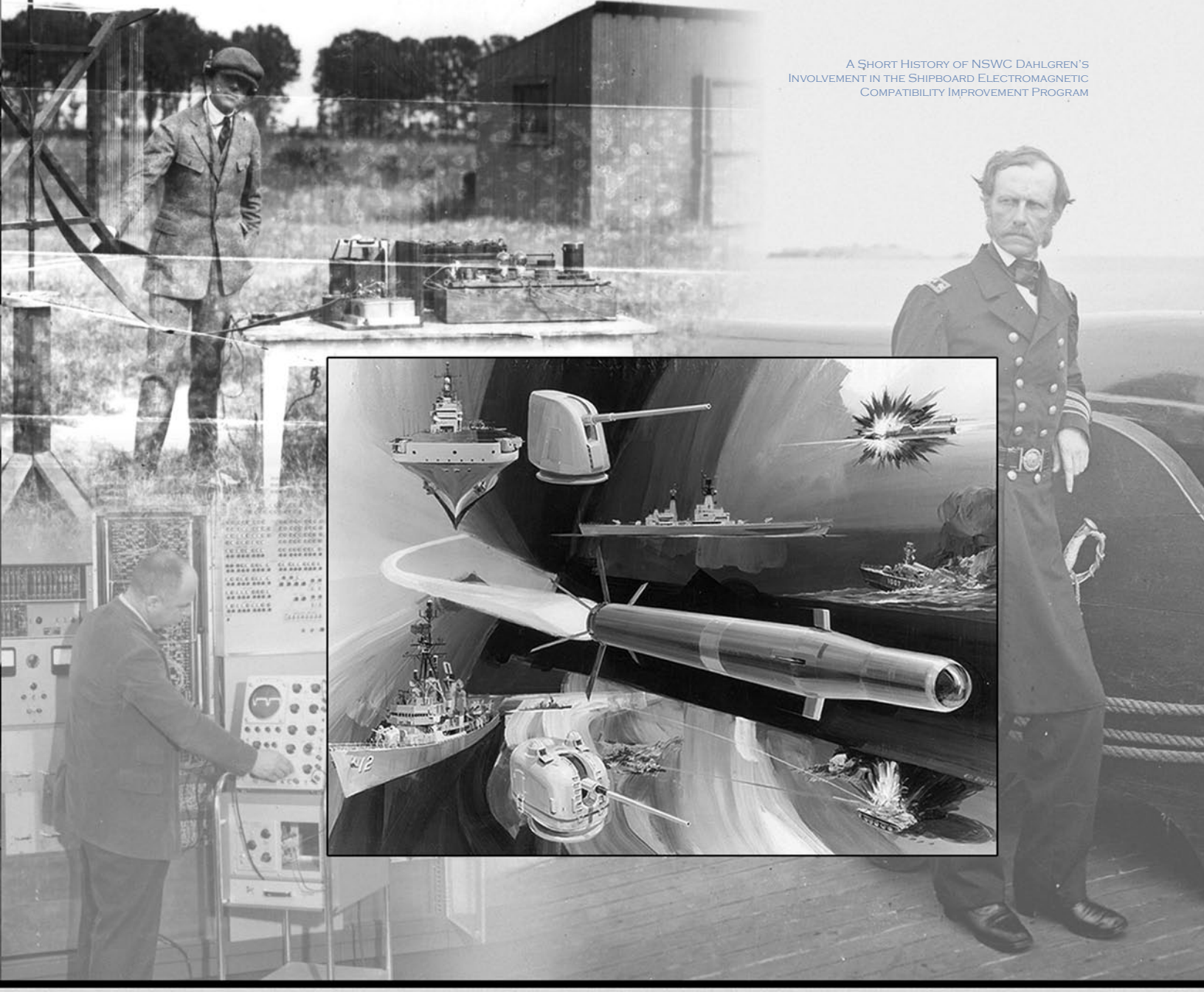
A Short History of NSWC Dahlgren's Involvement in the Shipboard Electromagnetic Compatibility Improvement Program

By George Winters

The Navy's first wireless message was transmitted from USS *New York* (CA 2) to a naval shore station in Navesink, New Jersey, in November 1899.[1] In his report dated 1 October 1900, R. B. Bradford, Chief of the Bureau of Equipment, stated that the results of these early experiments were very favorable. However, one serious defect was noted in the usefulness of the Marconi system of wireless telegraphy. This defect was referred to as "interference" and was described as follows:

> When signals are being transmitted from one station to another, as between USS *New York* and the Highland Lights, for instance, and another vessel comes within signaling distance and attempts communication with the Highland Lights, then the signals from the two ships become confused, and the receiving station on shore is unable to distinguish between them.[2]

The two ships were USS *New York* and USS *Massachusetts* (BB 2).[3] At the time, each ship was equipped with a single wire antenna and a wireless telegraph apparatus. The interference was caused by the fact that all transmitters and receivers operated at the same frequency. The transmitters had a very broad spectrum content. The frequency of the radio frequency (RF) energy being radiated was simply dependent on the length of the



antenna. A photograph of USS *New York* is shown in Figure 1.

The U.S. Navy quickly embraced this new wireless technology. No longer was a ship out of communication range when it sailed over the horizon. Beginning in 1902, all new Navy ships were expected to have provisions for installing a wireless telegraph apparatus. In 1904, the Navy began constructing a global broadcasting network.[1]

During these early years, interference continued to be mentioned as a problem in Annual Reports of the Navy Department and was one of the factors considered in determining what wireless apparatus would be adopted by the Navy. The *Annual Reports of the Navy Department for the Year 1905* notes:

> Comparative tests of apparatus furnished by a number of wireless telegraph companies have been made, particular attention being given to methods of secrecy in sending, and prevention of interference with messages being sent; also to ascertaining the relative value of the various systems.[2]

For the next 80 years, the number and types of shipboard electronic equipment using the RF spectrum proliferated at a seemingly ever-increasing pace. As the shipboard electromagnetic environment became more complex, there was a corresponding increase in the number of shipboard Electromagnetic Interference (EMI) problems. Today, EMI is defined as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. Electromagnetic Compatibility (EMC) is defined as the ability of all

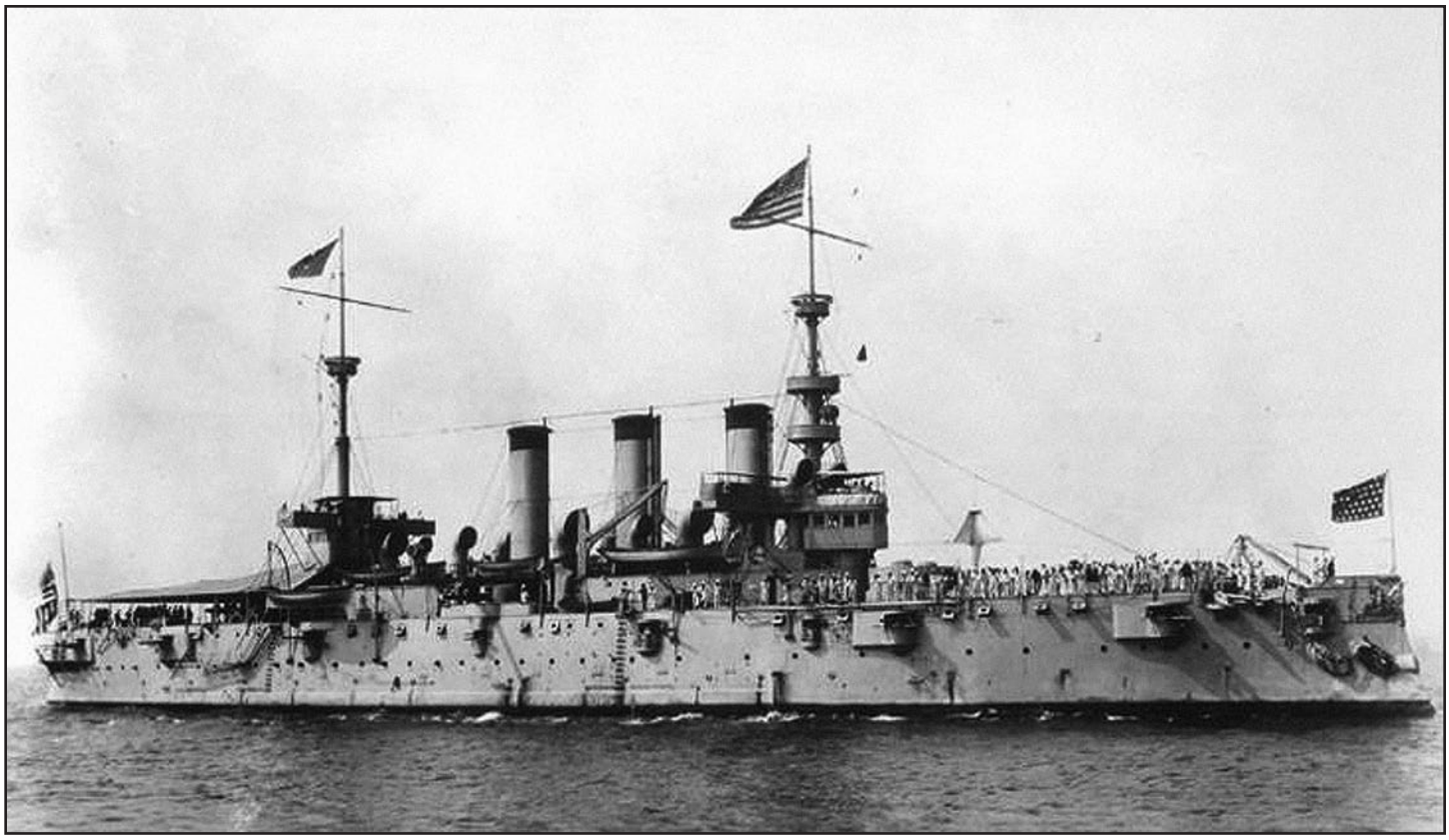


Figure 1. USS *New York* (CA 2) taken in the Summer of 1898. The wireless system's antenna ran from a wooden mast mounted on the topmast to the after gun room. (Navy Historical Center Photograph)

equipment, systems, and platforms to operate in their intended operational environments without causing or suffering unintentional performance degradation or harmful reactions as the result of EMI.

In 1973, the Naval Sea Systems Command (NAVSEA) recognized the need to mitigate EMI aboard its ships. It established a small team of highly skilled specialists to test, evaluate, and correct shipboard EMI problems. The program was called the Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP). The Naval Surface Warfare Center, Dahlgren Division (NSWCDD) was part of this original team of specialists. NSWCDD assumed the responsibility for resolving shipboard radar-related EMI problems and assigned one engineer to provide part-time support to SEMCIP.

Due to the increased visibility brought about by the Board of Inspection and Survey (INSURV), the Navy as a whole began to recognize that the operational readiness of ships, submarines, and aircraft were being significantly impacted by EMI. Something needed to be done. In 1978, a Chief of Naval Operations Executive Board (CEB) was stood up to address the "Management and Control of Electromagnetic Interference." In a CEB briefing given in 1980, Dr. Robert J. Haislmaier, Electromagnetic Spectrum Management Branch, Naval Communications Division of the Office of the Chief of Naval Operations, identified three EMI control programs that were making a difference in the fleet's EMI posture by correcting EMI problems. These were SEMCIP and two new startup efforts: NAVSEA's Waterfront Corrective Action Program (WCAP), and Naval Air Systems Command's Air Systems Electromagnetic Interference Corrective Action Program (ASEMICAP).[3]

Between 1973 and 1978, NSWCDD assumed a much greater role in SEMCIP. It was on its way to becoming the technical and programmatic lead for addressing Electromagnetic Environmental Effects (E3) issues on surface ships. During these 5 intervening years, the program had grown from one engineer to six. Accordingly, NSWCDD continued to provide technical leadership for shipboard radar EMI problem resolution. NSWCDD also began working with several NAVSEA radar program

managers to ensure that EMC was being built into new systems. A new Electronic Warfare (EW) system called the AN/SLQ-32 (see Figure 2) was being introduced into the fleet. Since the AN/SLQ-32 was both experiencing EMI problems from and causing problems to shipboard radars, NSWCDD EMI mitigation efforts expanded to include both radars and EW systems.

In the late 1970s and early 1980s, NSWCDD also began supporting a SEMCIP initiative to develop an E3 knowledge management system infrastructure. The goal was to provide a way of getting E3 information to ships and fleet support activities, where it could have a positive impact on fleet readiness. SEMCIP began by creating a number of E3 training guides. Six were published between 1977 and 1982. The two most popular were *The Commanding Officer's Guide to the Shipboard Electromagnetic Environment* (1977) and *The Electronic Materials Officer's Guide to Shipboard Electromagnetic Interference Control* (1978). The Commanding Officer's (CO's) guide was intended to provide the ship's Commanding Officer and Executive Officer with an understanding of the causes and effects of EMI problems typically found aboard their ships. The Electronic Materials Officer's (EMO's) guide was designed to complement and expand on the information provided in the CO's guide. It provided more detailed information, based on SEMCIP "lessons-learned," on how EMI could be successfully controlled aboard ship. While the CO's guide is no longer being published, the EMO's guide is still being updated and reissued. The latest version will be published later this year.

During the same time SEMCIP was developing E3 training guides, SEMCIP was also looking for a way of capturing and preserving EMI information in a centralized manner. This initiative was known as the SEMCIP Management Information and Tracking System (SMITS). SMITS consisted of several distinct, but interrelated series of computer files storing E3 information. Periodically, or on demand, the stored information would be pulled from the files and used to generate 1 of 10 standard reports. For example, a listing of the top 100 shipboard problems was generated each quarter; a master EMI problem index was generated semiannually; and a ship activity summary was prepared annually. While SMITS was originally conceived to provide E3 information to the Navy's design and acquisition managers, it also served to provide E3 information to all SEMCIP and Navy E3 Program participants. It tracked all SEMCIP technical reports, briefings, messages, and other E3-related material, and allowed originally microfiched documents to be retrieved from an associated SEMCIP library.

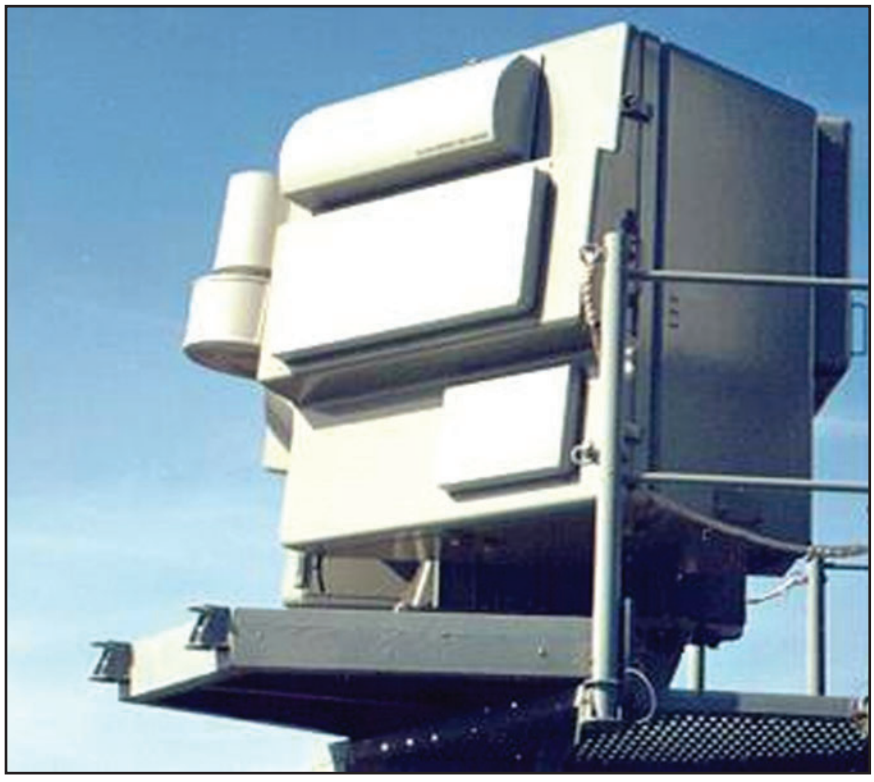
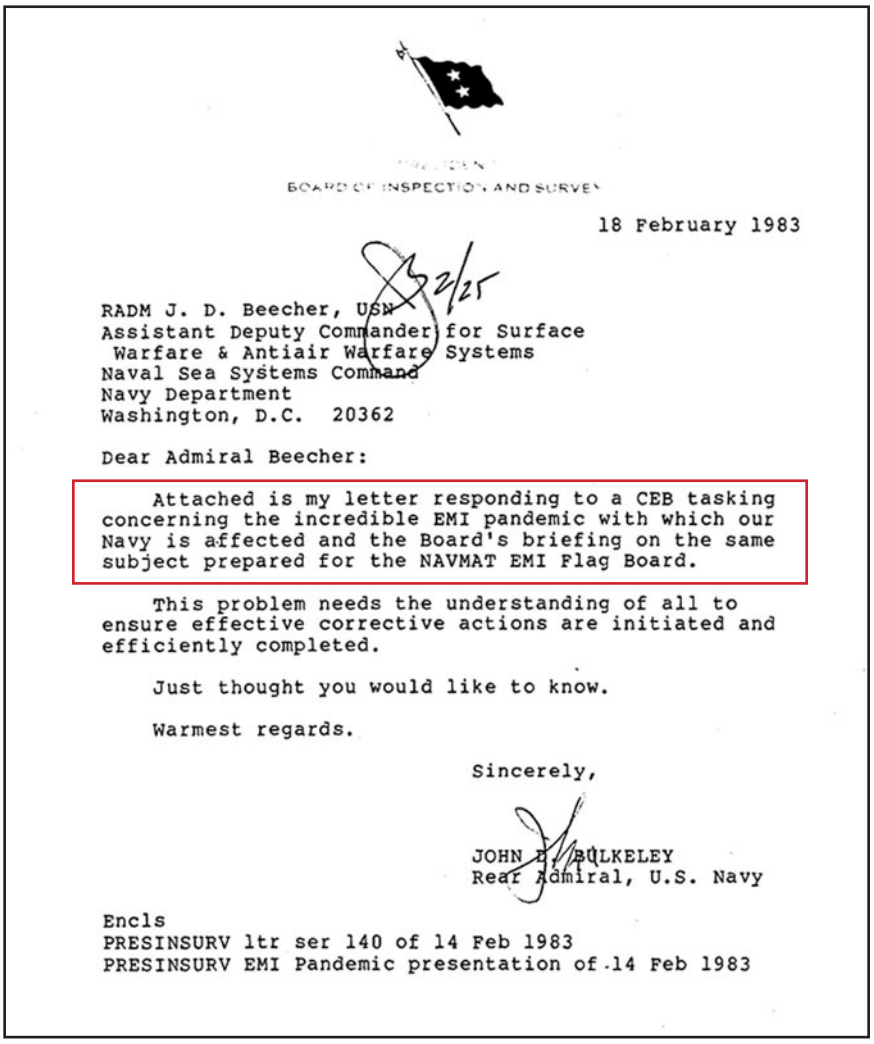


Figure 2. AN/SLQ-32 Antenna Enclosure

In the 1982 and 1983 time frame, two events occurred that added new urgency to the Navy's EMI control efforts. The first was the sinking of HMS *Sheffield* during the Falkland's War by an Argentine aircraft. HMS *Sheffield* was widely reported to have been sunk due to an EMI problem. The ship's radars were reported to be effectively disabled when permission was given to transmit messages back to London using its satellite communication system.[4]

The second event was a series of letters from Rear Admiral J. B. Bulkeley, President, INSURV. One was a personal letter to Rear Admiral J. D. Beecher, Assistant Deputy Commander



BOARD OF INSPECTION AND SURVEY

18 February 1983

RADM J. D. Beecher, USN
Assistant Deputy Commander for Surface
Warfare & Antiair Warfare Systems
Naval Sea Systems Command
Navy Department
Washington, D.C. 20362

Dear Admiral Beecher:

Attached is my letter responding to a CEB tasking concerning the incredible EMI pandemic with which our Navy is affected and the Board's briefing on the same subject prepared for the NAVMAT EMI Flag Board.

This problem needs the understanding of all to ensure effective corrective actions are initiated and efficiently completed.

Just thought you would like to know.

Warmest regards.

Sincerely,

JOHN [illegible] BULKELEY
Rear Admiral, U.S. Navy

Encls
PRESINSURV ltr ser 140 of 14 Feb 1983
PRESINSURV EMI Pandemic presentation of 14 Feb 1983

Figure 3. Letter from the President of INSURV dated 18 February 1983

for Surface Warfare Systems, NAVSEA. The leading paragraph of this letter is shown in Figure 3.

In the enclosure to this letter, RADM Bulkeley noted,

> "The Board has frequently underscored the apparent lack of system engineering at the ship and warfare levels when commenting upon fleet EMC deficiencies. The Board recommends that the Chief of Naval Material establish an effective in-house EMC engineering capability that can address EM system performance issues during the entire life cycle of new ships and existing fleet ships."

Attached to this enclosure was a prioritized listing of 34 unresolved EMI deficiencies. Twenty-four of these deficiencies were identified as impacting the ship's ability to perform its mission. Ten additional EMI problems were noted, but were not considered to be degrading ship performance.

In December 1982, Dr. Haislmaier—the man recognized as being the founder for the present-day Navy E3 Program and the man after which the Navy's Haislmaier Award is named—laid out his vision/goal for the Navy's EMI Control Program. It was to "institutionalize EMC/EMI control in the Navy."[5] He proposed five objectives to meet this goal; they were:

- Do it right the first time
- Make it work right if it doesn't
- Use it right
- Keep it working right
- Support these efforts with needed technology

Today, Dr. Haislmaier's vision lives on. The requirement for a centralized or core Navy E3

program called "SEMCIP" was recently reconfirmed in the latest Chief of Naval Operations Instruction, *Electromagnetic Environmental Effects (E3) and Spectrum Supportability Policy and Procedures*.[6] The instruction assigns responsibility for maintaining this core Navy E3 capability for fleet and shore facilities to NAVSEA. NAVSEA, in turn, assigned this responsibility for surface ships and strike groups to the Electromagnetic Effects Division at NSWCDD.[7]

In 1983, INSURV identified 24 EMI deficiencies that were degrading ship mission capabilities. Today all of these originally 24 deficiencies have long since disappeared. Of the 10 nonmission degrading EMI problems, only 2 can still be found aboard ships today. NSWCDD played a key role in resolving the majority of these problems on surface ships. Since 1983, the number of antennas aboard surface ships has roughly doubled. The electromagnetic environment has become even more complex. EMI is still a problem but is no longer discussed as a "pandemic" problem. Over the last 30 years, the Electromagnetic Effects Division at NSWCDD can claim much of the credit for mitigating EMI aboard surface ships and for helping to implement Dr. Haislmaier's vision for the Navy.

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6. Chief of Naval Operations Instruction 2400.20F, *Electromagnetic Environmental Effects (E3) and Spectrum Supportability Policy and Procedures*, dated 19 July 2007.
7. *Memorandum of Agreement Between Deputy Commander for Warfare Systems Engineering*, Sea 06 Director, Battle E3 Engineering and Spectrum Management SEA 62E, and Commanding Officer NSWCDD, Code J50, dated 5 May 2004.